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LATITUDINAL DISTRIBUTION OF ONYGENALES AND RELATED HYPHOMYCETES IN SOILS OF NORTHERN CHILE BETWEEN 18 - 34º SOUTH LATITUDE

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Key words: Keratinophilic **Onygenales,** habitat, distribution.

SUMMARY

In the course of 1985 up to 1989, 332 soil samples were studied by using the keratinic bait technique. Qualitative and quantitative variations of the **Onygenales** *population and associated* **Hyphomycetes** *(47 species) between urban-peripheric and wild habitats of coastal and inland areas, in a latitudinal gradient (18-34ºS) of the Chilean territory were explored.*

Highest isolates were found in urban-peripheric areas, being **Chrysosporium, Aphanoascus, Malbranchea, Trichophyton** *and* **Gymnoascus** *the dominant genera.*

Holomorph taxa such as **Aphanoascus fulvescens, A. keratinophilum, A. verrocosus, Arthroderma quadrifidum** *and* **Gymnoascus reesii** *were considered as euridominant because of their maintaining dominance and constancy in all latitudes studied.*

At the same time, reproductive-multiplicative strategies of the community, their patterns of latitudinal distribution and the biogeography, associations of species, certain ecological parameters (Shannon-Weaver diversity and Pearson affinity) were analyzed to finish with the taxonomic comment and the present unstable nomenclature.

RESUMEN

Entre los años 1985-1989, se estudiaron 332 muestras de suelo mediante la técnica del anzuelo queratínico. Se exploraron las variaciones cualitativas y cuantitativas de las poblaciones de **Onygenales** *e* **Hyphomycetes** *relacionados (47 especies), entre los habitat Urbano-periférico y Silvestre de zonas costeras y del interior, latitudinal (18-34ºS) del territorio chileno.*

Los mayores aislamientos correspondieron a zonas urbano-periféricas, siendo los géneros dominantes: **Chrysosporium, Aphanoascus, Malbrancea, Trichophyton** *y* **Gymnoascus**.

Los taxa holomorfos **Aphanoascus fulvescens, A. keratinophilum, A. verrucosus, Arthroderma quadrifidum** *y* **Gymnoascus reessii,** *se consideraron como euridominantes, por mantener una dominancia y constancia en todas las latitudes estudiadas.*

Al mismo tiempo se analizaron las estrategias reproductivas-multiplicativas de la comunidad sus patrones de distribución latitudinal y la biogeografía, las asociaciones de especies, ciertos parámetros ecológicos (diversidad de Shannon-Weaver y afinidad de Pearson), finalizando con la problemática taxonómica y la inestable nomenclatura actual.

INTRODUCTION

The flora and fauna exhibit distinct latitudinal gradients of distribution which in the microscopic mycota of soils have been discussed in more detail since the second half of our century by using reasonable sampling methods (1, 2, 3, 4, 5, 6, 7, 10, 26, 44).

While it is true that the distribution of dominance, frequency or rareness of species is well known in some fungal groups (4,8,9), in the **Onygenales** (= Gymnoascales) and related taxa there is available only information gathered mostly with reference to the biotroph species of the group (87,88,89, 90).

Upon analyzing the literature on taxon an orientation based mainly on a controversial and confused taxonomic race that it reconfirms only the known and old concept of heterogeneity of **Onygenales** and that of the taxonomists' opinion who study them is quite evident. (11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22).

The vegetational parameter is considered in the studies of the parasitic or symbiotic macrofungi as the substratum most frequently used by these organisms, with some exceptions. For this reason

the autotrophic community represents a more efficient and immediate source of environmental information than the study of soil, climate, geography or orography of the sampling zones. In the case of saprotroph microfungi of the soil, sometimes the vegetational parameter, in spite of its importance, affords a restricted piece of information because of the presence in this habitat of different usable substrata. This is why the fauna (mesofauna included, 92) and the human population density allow also very useful information, due to its close relationship with the scattering of viable propagules for new habitats. In these cases, the attempts to elucidate fungal functions by means of studies on pure cultures of the degrading ability of individual taxon are recommended to get some ecological conclusions (46, 65).

The great spatial variety connected with the microfungi distribution is due to the fact that soil represents a mosaic of microhabitats for the development of microorganisms, which requires strict quantitative studies with the applications of statistical analyses to explain fungal distribution by means of biotic and abiotic variables and through direct or indirect sampling methods. However, it is not always easy to recognize the nature or the number of individuals in a particular place.

We do not know much yet about the function of their populations in the microbiota of the different telluric habitats and the composition of the structure of their communities, except that by means of sampling techniques with keratinic baits (hair and feathers), it is possible to detect their presence in many soils of the world, ranging from the richest in organic nutrients to the poorest and most deserted ones. at different latitudes and heights. This asseverates the wide cosmopolitan distribution of their teleomorphs and anamorphs mainly in soils containing a high humus content, or animal excrements (11, 23, 24, 25, 27, 28, 29, 30), but also on the hair and feathers of the former under every climate of the world (31, 32, 33, 34).

Controversies seem to go on when we intend to apply to these fungi those theories or hypotheses aiming to explain the variety of species in the community (time, competence, space heterogeneity, climatic stability, etc.) where clear overlappings can be seen; therefore, the abundance or rareness of species can be related to multiple edaphic factors (physical-chemical) or to another biotic or abiotic features difficult to be quantified (35, 36, 37, 38, 39). Furthermore all of this seems not to be sufficient if we do not relate their presence in situ with the keratinic substrata in the soils provided by the fauna, including man, thus the keratine becomes a potential reservoir for their saprotroph or potentially biotroph communities.

Considering the above, our first part in this research intends to analyze: 1) The distribution of these fungi in a latitudinal gradient of the Chilean big and small north (2000 km approximately), with the purpose of providing more ecological information to the little one already gathered in the mentioned territory (25, 40, 91). 2) Their presence in extreme environments which represents about 2/3 of analyzed territory

MATERIALS AND METHODS

a) Geographical location of the sampling areas

332 soil samples taken from coast and inland zones belonging to the first 5 regions of the Chilean territory (North and a part of central Zone) were analyzed. Regional boundaries were not considered and this part of the country was subdivided into 4 groups of latitudes, each with a 4º S-difference (450 kms. approximately). The former, starting from the northern frontier with Perú, include the following latitudes: 18º-22º S, 22º-26º S, 26º-30º S, 30º-34º S. In figure 1, the 4 latitudinal zones with the sampling places selected in different transects between the coast and inland, are given in detail. A coast zone is considered to be that one encompassing from the sea as far as 10 km-maximum towards inland, while the inward zone is the one which is more than 10 km away from the coast and which reaches as far as pre-mountain chain zones. Coast and inland habitats in turn were divided into two new habitats: 1. The urban-peripheric one, meaning peripheric boundary as the area stretching from the perimeter of the city or village as far as some 3 to 5 kms. of distance. 2 The wild one that includes the environment far from the urban centers, at a distance greater than 5 km of the city periphery and with low human activity signs.

b) Sampling

Samples were taken among years 1985-1989 always in the same season of the year, from May to June (Autumn), and it consisted in the removal of 50 to 100 g. of surface of the soil (1 to 5 cm deep) by means of a sterilized trowel. Each representative sampling unit either of the urban-peripheric or wild habitat, consisted in a pool of 5 sub-units taken at

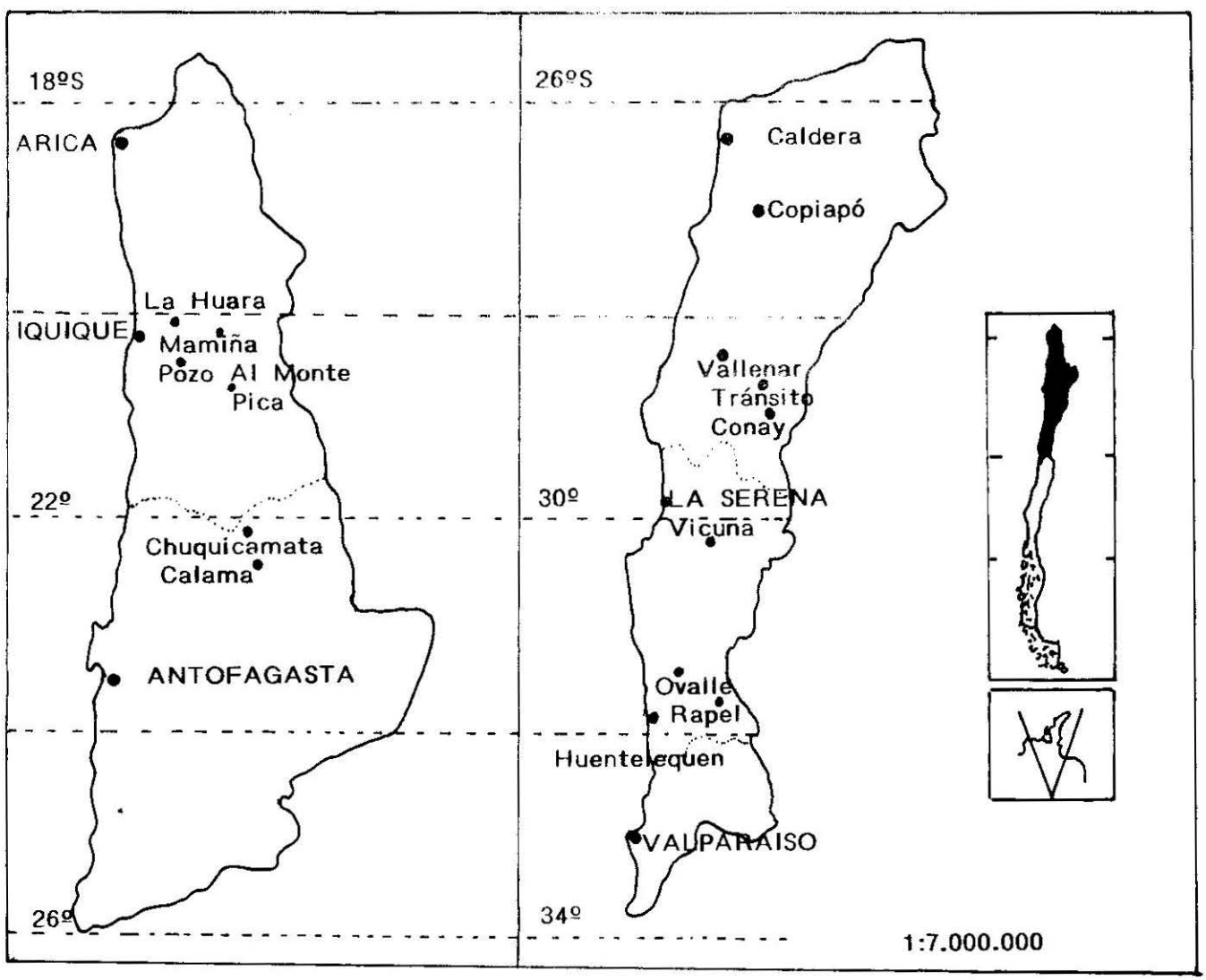
random from an approximate 50 m2 area. In each geographical sampling spot, a minimum average of 5 samples in wild areas and one generally greater than 10 in an urban-peripheric area were got the soil samples obtained were deposited in sterile plastic bag and sealed to prevent the lost of humidity. All the samples were freezed (-20º C) for 1 week to inhibit the mites.

c) **Seeds and Cultures**

After freezing soil samples were processed according to the modified Orr's technique (26). Soil's were arranged evenly on 12 cm diameter sterile plates until covering half their height, sterile pre-pubescent human hair being added on the surface. The soil with its keratinic bait on the

Figure 1

MAP OF NORTHEN CHILE SHOWING COLLECTION AREAS



surface was moistened with sterile distilled water added with chloramphenicol (0,10 g/l) and cyclohexamide (0,4 g/l). Plates were incubated at room temperature of the laboratory (16 to 20º C) for a 4-month maximum period. In order to avoid dehydratation, they were occasionally added sterile distilled water. The observation of the fungal growth began as for the fifteenth day and later on at 15-20 day intervals. The control of the fungal growth on the keratinic bait was carried out with a stereomicroscope and isolates took place either by a direct observation or cultures with a fine needle.

The frequency of occurrence of colonies of some Onygenal species or related fungus was counted only once for each petri dish, overlooking the number of times it could get repeated on it.

Relevant fungal species were isolated directly from the plates under the steromicroscope by using 3 kinds of agar: Corn Meal (CMA), Potato carrot with yeast extract (1/1000) (PCA) and Potato dextrose (PDA). Cultures were incubated at 25-27º C. The identification of isolates was based on monographies and keys mentioned in the references.

d) **Statistical processing**

To estimate the stability of the mycocenosis in a place, the Shannon-Weaver diversity for species isolated in that "place" (habitat or latitude) was calculated.

$$H = \{ Ni/N \log^2 Ni/Ni = 1, 2, ..., s$$

where:
s = number of species isolated in the "place"
Ni = number of isolations of the specie i in the "place"
N = Total of isolates in the "place"

The affinity of species and isolates of a pair of "places" was estimated by means of Pearson index of correlation:

$$r = \frac{\Sigma ni\, mi - \frac{(\Sigma ni)(\Sigma mi)}{S}}{\sqrt{\left(\Sigma ni - \frac{(\Sigma ni)^2}{S}\right)\left(\Sigma mi^2 - \frac{(\Sigma mi)^2}{S}\right)}}$$

where:
Ni = number of isolates of the species i in a "place"
Mi = number of isolates of the species in the other "place"
S = Number of pair of species of both "places"

To stablish which latitudes and habitats were forming a similar conglomerate acording to the presence of species, cluster analysis, complete - linkage, clustering computed on the basics of the Pearson's correlation matriz was used, and principal component analysis was performed on the covariance matrix sample.

A BIOGEOGRAPHICAL OUTLINE OF THE STUDIED AREAS

Due to ecological conditions, mainly influenced by the climate, the orography and the anthropic action, the distribution and composition of the biomassof Chile is not simple. The marked latitudinal largeness and the orography are used as useful elements to distinguish certain types of ecosystems (56, 57, 58), which in our collection areas we call Xeromorphic, Mesomorphic and Andino, according to Pisano's classification (55), which have different characteristics of flora and fauna.

Xeromorphic ecosystem

It includes the first three regions of the country (Tarapacá, Antofagasta and Calama) among 18-30º south latitudes approximately and the characteristics of which are very similar in soil, climate and relief. It is characterized by a scarce vegetal coberture that is never continuous and by the singular adaptation of the species to the unsatisfactory conditions of humidity. It has huge areas for mining exploitation yet their population density is very low (about 3 inhabitants/km2 gathered mostly in urban zones).

Soils

Surfaces being 26.164.000 hectares of which 60% are natural prairies of the altiplano (Andino ecosystem, not considered in our study) fit for wild life mostly. The texture of the soil is mainly fine

sandy, tropical red type (scarce) or mostly skeletal (litosoil or regosoil), almost free of organic matter, except in zones where there are water streams or underground nappes (oasis).

Climate

In the narrow coast strip (5 to 10 Km), a littoral desert-like climate with minimum precipitations that increase slightly towards the south (0,7 mm in Arica; 7,7 mm in Antofagasta) can be seen. Low and homogeneous (15-18º C) mean temperatures, constant fog.

In the inland zone, among 18-29º south latitudes, approximately, there is a normal desert-like climate with clear skies, a great atmospheric dryness and severe temperature fluctuations (sometimes greater than 40º C between day and night). Absolute absence of precipitations all the year through.

Flora

The littoral desert-like zone exhibits a scarce vegetation mostly cacti and coast desert-type bushes. Herbaceous species are scarce.

In the inland zone (without considering the preandina or andina zone), flora is purely desert-like, with no vegetation or very little. Presence of **Bromeliaceae (Tillansia lanbeki)**, **Adesmis** sp. and **Atripex** sp. Absence of woody zones, except for the existence of only one type of tree, the tamarugo (**Prosopis tamarugo**), scattered in some areas. In some small "ayllus" (oasis) and valleys, there is a reduced agriculture, with the presence of herbs, bushes and some trees.

Fauna

In the coast zone, the presence of marines birds is remarkable, scarce turtles, rodents, depredators and cattle: limited mesofauna.

In the inland zone, in stony environments, some lizards and birds (mainly **Tordus chiguanco**). In the oasis zones there is a wide variety of birds, rodents, insects and mesofauna.

In general, live beings of the desert-like ecoregions keep a constant fight against their hostile environment, where plants and animals survive only in small communities.

Mesomorphic-temperate ecosystem

It can be subdivided into 2 classes:

1)The one located among 30-32º south latitude including the 4th Region of the country, Coquimbo (Regional Capital, La Serena). It is considered as a transitional zone, xeromorphic of the Chilean North and the higromorphic of Southern Chile. It has a complicated orography due to the transverse mountain chains which determine the existence of closed deep valleys. It is a purely semi-dry zone, with a > 50 inh/km2 population density in the urban-rural zone.

Soil. Their surfaces correspond to some 4.000.000 hectares approximately, 60% of which are adapted to the wild life. They are soils influenced by the climatic dryness, aridisol and afisol type, (without considering the andino ones), light colored, rich in salts and carbonates, generally free of clays, Shortness of organic matter in zones far from hydric zones.

Climate. In coast zone, stepperic climate with plentiful clouds, precipitation increase (133 mm yearly in La Serena city). Low and homogeneous mean temperatures (14,7º C).

In the inland zone, the same climate yet with a great atmospheric dryness, moderate precipitations (100-150 mm yearly). Transverse mountain chains produce wide zones of air dryness with high mean temperatures in summer (28º C). The dryness period lasts about 8 months, having rains only in winter.

Coast and inland zones show some deep erosion caused by the destruction of the forest and the overpasturing of goats, one of the most important agents in the environment degradation, with a tendency to the coming back of desert-like habitats. The dryness period lasts about 8 months, with rainy periods mainly in winter.

Flora. In coast zone, clear sub-desert like bush and spiny bush (Cacti). Scarce woody communities and some areas for agriculture-cattle breeding exploitation, favored by the existing rivers.

The inland zone is mainly shrubby, prevailing an extremely xeromorphic (Cacti) clear and low

bush, with plants adapted to the dry and sunny environment (**Puya chilensis**). There is plenty thorn (**Acacia caven**), some gramineous plants and forage herbs, especially **Atripex** species, which play an important role for the cattle.

Agricultural exploitation areas related with the basins of the rivers.

Fauna. Mainly poor, in the coast there is predominance of marine birds while land birds are observed in connection with valleys provided with irrigation. Few mammals, some rodents and their natural depredators, cattle is chiefly made up of goats.

2) The one lying among 32 to 34º south latitude which corresponds to the 5th region of the country (regional capital, Valparaíso). Beginning of the mesomorphic ecosystem, where a progressive aridity decrease and a precipitation increase are observed. The height of the coast mountain chain protects inland zones from the marine action. These latitudes are the most anthropized of the country, with a regional population density greater than 250 inhabitants/km2, distributed mainly in urban areas.

Soils

Their surface corresponds to 1.640.000 hectares, 50% of which are fit for forestal activity, a 30% for wild life and the rest for cultivation. Alfisol-type or prairie-type soils in coast zones. In inland zones they are of the entisoil type, belonging to the drab not calcareous group (in zones of moderate precipitations) and to the alluvial and humic group (in humid zones).

Climate

Chiefly temperate, of the Mediterranean type either in the coast as well as inland. However, in the coast mean temperatures are more moderate because of the oceanic influence (14,8º C in Valparaíso), with constant morning foggy days and a mean 360 mm rainfall, very variable according to the years (reference Valparaíso city).

In the inland zone there are continental tendency areas with severe thermic fluctuations and dry air, having mean temperatures greater than 27º C in summer, due to the action of the coast mountain chain. There is a good agricultural activity in irrigated soils because they are rich in organic matter.

Flora

In the coast zone, abundant herbs and gramineous plants, with a coast mesomorphic shrubby steppe, cultivation areas, forestal plantations (**Pinus** spp. **Eucaliptus** spp., **Populus** spp, etc.) and a sclerophilic native forest (very degraded) are observed. In more humid zones, the Chilean palm (**Jubea chilensis**). In the inland zone, abundant herbs and gramineous plants are seen, a clear schlerophilic bush, a schlerophilic forest and steppe-like communities of thorn (**Acacia caven**). Areas with good agricultural exploitation. The native vegetation loses importance before the introduction of foreign species.

Fauna

These latitudes exhibit the greatest variety of fauna in the country either of marine birds as well as land ones and small-size mammals. Different kinds of cattle and abundant mesofauna.

RESULTS AND DISCUSSION

In the present paper that includes around 1/3 of the national territory, of the 332 petri dishes under examination, 904 keratinophilic-lytic fungal isolates which belong to 45 species (17 genera) were isolated, and are described in detail in Table 1.

In 74 (22.8%) of the soil samples collected from all latitudes examined, there was absence of growth of **Gymnoascales** and related fungi. The highest negativity was observed in wild places either coastal (33,33%) as well as inland (30,76%) Table 3.

The greatest number of fungi isolates per plate in every latitude was detected in the Urban-per. habitat, mainly inland and within 26 to 34º S latitude. (Tables 2 and 3).

Peculiar geographical conditions of continental Chile makes it possible advantages in the utilization of some parameters such as: latitude, habitat and population density (men and animals in relation to Urban-peripheric and Wild Zones).

Table 1
Isolated species

Abbreviations used in tables and figures	Number of isolates	
(AMA a)	**Amauroascus aureus** (Eidam) von Arx	9
(AMA e)	**Amauroascus echinulatus** (Dutta & Ghosh) von Arx	3
(APH k)	**Aphanoascus keratinophilus** Punsola & Cano	34
(APH f)	**Aphanoascus fulvescens** (Cooke) Apinis	59
(APH t)	**Aphanoascus terreus** (Randhawa & Sandhu) Apinis	1
(APH v)	**Aphanoascus verrucosus** Cano & Punsola	24
(ARA n)	**Arachnomyces nitidus** Massee & Salmon	1
(ARA s)	**Arachnomyces sulphureus** Massee & Salmon	1
(ART g)	**Arthroderma gypseum** (Nannizzi) Weitzman, McGinnis, Padhye & Ajello (= **Nannizzia gypsea** (Nannizzi) Stockdale.	6
(ART q)	**Arthroderma quadrifidum** Dawson & Gentles	25
(ART u)	**Arthroderma uncinatum** Dawson & Gentles	10
(AUXca)	**Auxarthron californiense** Orr & Kuehn	2
(AUXco)	**Auxarthron conjugatum** (Kuehn) Orr & Kuehn	19
(AUX u)	**Auxarthron umbrinum** (Boudier) Orr & Plunkett	20
(CHR k)	**Chrysosporium keratinophilus** (Frey) Carmichael	51
(CHR t)	**Chrysosporium tropicum** Carmichael	46
(CHR p)	**Chrysosporium pannicola** (Corda) van Oorschot & Stalpers	47
(CHR m)	**Chrysosporium merdarium** (Link ex Grev) Carmichael	20
(CHR c)	**Chrysosporium carmichaelii** van Oorschot	5
(CHR i)	**Chrysosporium indicum** (Randhawa & Sandhu) Garg	8
(CHR v)	**Chrysosporium vallenarense** van Oorschot & Piontelli	4
(CHR.Af)	**Chrysosporium** sp. anamorph of **Aphanoascus fulvescens**	28
(CHR.sp)	**Chrysosporium** sp.	4
(CTE s)	**Ctenomyces serratus** Eidam	29
(GEO pp)	**Geomyces pannorum** (Link) Sigler & Carmichael var. **pannorum**	2
(GEO pa)	**Geomyces pannorum** (Link) Sigler & Carmichael var. **asperulatum** (Sigler & Carmichael) van Oorschot	20
(GMA a)	**Gymnascella aurantiaca** Peck	21
(GMAci)	**Gymnascella citrina** (Massee & Salmon) Orr, Ghosh & Roy	2
(GMAco)	**Gymnascella confluens** (Sartory & Bainier) Currah	1
(GMA d)	**Gymnascella dankaliensis** (Castellani) Currah	35
(GMA l)	**Gymnascella littoralis** (Orr) Currah	2
(GMA.sp)	**Gymnascella** sp.	1
(GMO i)	**Gymnoascus intermedius** Orr	4
(GMO r)	**Gymnoascus reessii** Baranetzky	60
(KER a)	**Keratinomyces ajelloi** Vanbreuseghem	28
(MAL d)	**Malbranchea dendritica** Sigler & Carmichael	23
(MAL s)	**Malbranchea sulfurea** (Miehe) Sigler & Carmichael	3
(MAL Ur)	**Malbranchea** anamorph of **Uncinocarpus reesii** Sigler & Orr	34
(MAL spp)	**Malbranchea** spp.	6
(MIC g)	**Microsporum gypseum** (Bodin) Guiart & Grigorakis, complex	37
(MIC c)	**Microsporum cookei** Ajello	11
(MYC v)	**Myceliophthora vellerea** (Sacc & Speg) van Oorschot	56
(MYX d)	**Myxotrichum deflexum** Berkeley	4
(ONC f)	**Oncocladium flavum** Wallroth var. **flavum** and **Malbranchea** synanamorph (= **Malbranchea flava** Sigler & Carmichael)	21
(TRI t)	**Trichophyton terrestre** Durie & Frey, complex	68
(UNC r)	**Uncinocarpus reesii** Sigler & Orr	9
	TOTAL	904

Table 2 **Isolated taxa (%) according to latitude, with mention to their dominance and constance.**

Taxa	Southern Latitude				Dominance (D, d) Constance (C)
	18 - 22º	22 - 26º	26 - 30º	30 - 34º	
DOMINANT and CONSTANT TAXA (EURIDOMINANT)					
APHk - CHRk	4.03	**10.6***	**10.0**	**10.4**	D C
APHv - CHRt	**13.7**	**11.8**	**6.5**	**6.0**	D C
APHf - CHR.Af	**10.5**	**7.1**	**9.0**	**10.4**	D C
ARTq - TRIt	**5.7**	3.5	**7.7**	**15.3**	D C
GMOr	**8.1**	**9.4**	**8.4**	4.2	D C
CONSTANT and DOMINANT TAXA (STENODOMINANT)					
GMAd	**15.3**	**7.1**	2.9	0.3	d C
UNCr - MAL Ur	**13.7**	**5.9**	3.9	2.3	d C
CTEs - MYCv	4.8	2.4	**12.9**	**9.6**	d C
ARTg - MICg	-	**5.9**	3.6	**7.0**	d C
GMAa	**5.7**	**9.4**	1.1	-	d C
CHRm	4.0	**7.1**	1.3	1.3	d C
GEO pp	4.0	**5.9**	-	2.6	d C
ARTu - KERa	-	-	1.9	**8.3**	d
CHRp	-	-	4.2	**8.8**	d
CONSTANT TAXA					
MAL spp	0.8	3.5	0.3	0.3	C
MALd	0.8	-	1.9	4.2	C
ONCf	3.2	-	2.3	2.6	C
AMAa	0.8	1.2	2.3	-	C
CHRc	0.8	1.2	1.0	-	C
APHt - CHRi	-	-	2.6	0.3	
CHRv	-	-	0.7	-	
CHR sp	-	-	1.3	-	
MIC c	-	-	1.0	2.1	
MAL s	0.8	-	-	0.5	
GEO pa	0.8	-	-	0.3	
AMAe	1.6	-	-	0.3	
ARAn	-	-	0.3	-	
ARAs	-	1.2	-	-	
AUXca	-	-	-	0.5	
AUXco	-	-	4.8	1.0	
AUXu	-	-	4.8	1.3	
GMAci	0.8	-	0.3	-	
GMAco	-	-	-	0.3	
GMAl	-	-	0.7	-	
GMAsp	-	-	0.3	-	
GMOi	-	-	1.3	-	
MYXd	-	4.7	-	-	
Total of isolations	124(1.8)	85(1.8)	310(2.9)	385(3.6)	
Nº of negative plates	27	11	22	14	
Total of plates	68	48	108	108	

* Detached number = Dominance over 50%

In brackets "density of isolates by plates".

Table 3 **Isolated taxa (%) according to habitat, with mention to their dominance and constance.**

Taxa	Habitat				Dominance (D, d) Constance (C)
	Coast: Urban-per	**Coast: Wild**	**Inland: Urban-per**	**Inland: Wild**	
DOMINANT and CONSTANT TAXA (EURIDOMINANT)					
APHk - CHRk	**7.7***	**9.6**	**10.8**	**7.8**	D C
APHv - CHRt	**8.2**	**12.3**	**7.9**	4.2	D C
APHf - CHR.Af	**14.2**	**9.6**	**8.6**	**5.6**	D C
ARTq - TRIt	**16.3**	4.1	**8.6**	**9.2**	D C
GMOr	1.3	**6.9**	**8.1**	**10.6**	D C
CONSTANT and DOMINANT TAXA (STENODOMINANT)					
GMAd	**5.6**	**5.5**	2.4	4.9	d C
CHRp	**10.3**	2.7	2.9	**5.6**	d C
CTEs - MYCv	3.0	1.4	**14.3**	**8.5**	d C
ARTg - MICg	**6.0**	-	**5.7**	2.1	d C
AUXco	-	**5.5**	0.2	**9.9**	d C
GEOpp	0.9	**9.6**	1.5	2.8	d C
UNCr - MAL Ur	1.7	1.37	**7.0**	4.2	d C
AUXu	0.45	**11.0**	0.9	4.9	d C
ARTu - KERa	**12.4**	-	1.5	1.4	d C
AMAa	0.9	**8.2**	-	0.7	d C
CONSTANT TAXA					
CHRm	0.9	1.4	2.6	3.5	c
MALd	2.2	1.4	3.5	0.7	c
MICc	1.7	4.1	0.9	-	c
AMAe	0.4	1.4	-	0.7	c
ONCf	0.9	-	4.0	0.7	c
GMAa	0.9	-	2.6	4.9	c
CHRc	0.9	-	0.7	-	
CHRv	-	-	0.7	0.7	
CHRs	-	-	0.4	1.4	
CHRi - APHt	-	-	0.9	3.5	
MALs	0.9	-	-	0.7	
MAL spp.	0.9	-	0.9	-	
GEO pa	0.4	-	0.2	-	
ARAn	-	-	0.2	-	
ARAs	0.4	-	-	-	
AUXca	0.9	-	-	-	
GMAci	-	-	0.4	-	
GMAco	-	1.4	-	-	
GMAl	-	-	0.4	-	
GMAs	-	1.4	-	-	
GMOi	-	1.4	0.7	-	
MYXd	-	-	0.7	0.7	
Total of isolations	233(2.9)	73(1.2)	456(3.6)	142(2.2)	
N° of negative plates	14	20	20	20	
Total of plates	81	60	126	65	

* Detached number = Dominance over 5%

In brackets "density of isolates by plates".

The relationship between the human-animal presence in the environment and the distribution of keratinophilic fungi in soils has been demonstrated by many papers (11, 23, 25, 26, 27, 28, 29, 30, 36, 39, 52) in different latitudes (mostly in the northern hemisphere), generally in direct relation to the quantity and quality of the prevailing organic matter (46), mainly supplied by the vegetable cover, the humus content, the presence of fatty acids (45) as well as the keratinic material (43) or other components. However due to the wide geographical distribution of their numerous taxa and their ability to metabolize as saprotrophic a great variety of substrata existing in the soils, they are able to colonize feather, fur, nail, hoof, horn, bone, dung, dropping, paper, decaying vegetable matter and other substrata (47). This variability in the production of enzymes induces to think of the fact that these fungi like other fungal groups are able to make use of different metabolic strategies under the nutritional stress and the habitat conditions (48) rendering difficult their position in strict degrading categories which are still under examination at present (52, 54, 17).

The varied keratinolytic, keratinophilic, cellulolytic or other properties common to the taxon (**Onygenales**) are not reasons enough to consider their particular enzymatic potentialities as an usual standard of the species in the habitat, but rather as a selective strategy of the dominant ecological situation for a particular substratum. This seems to be true in some of our isolates where the habitat and possibles varied substrata lodge the same species in the latitudinal gradient (Tables 2 and 3).

a) **Isolated genera**

The most dominant and representative genera according to their habitat in every latitude were in decreasing order: **Chrysosporium** Corda, **Aphanoascus** Zukal, **Malbranchea** Saccardo, **Trichophyton** Malmsten and **Gymnoascus** Baran. (Figures 2 and 3). **Chrysosporium** was the most abundant (density) genus in every latitude and habitat, reaching together with its teleomorph **Aphanoascus**, about 33-40% of the total isolates. Next in relevance is **Malbranchea** with a 9,4% (Figures 2 and 3). In spite of the extended literature about the presence of the genus **Chrysosporium** and **Aphanoascus**, there is not a uniformity of criteria that makes it possible to relate their presence in different habitats and soils with regard to the biogeography and climate. Our greatest isolates in the coast (Urban-per.) (Figure 3) would confirm the abundance of certain species in a littoral mediterranean climate (36, 49), a situation that can be easily seen to some extent in **Aphanoascus verrucosus, Chrysosporium tropicum** and **Chr. pannicola.** While species of the genus **Malbranchea**, seem to prefer the hottest and driest climates of the inland (Urban-per.) (Figure 3)

It is evident that **Aphanoascus** or its anamorph (**Chrysosporium**) are able to adapt themselves to different edaphic, climatic and nutritional situations keeping a constancy or dominance all over the latitudinal gradient, this is why they must be considered among the **Onygenales** with the highest competitive capacity.

b) **Isolated species**

b-1) **Dominance and constancy in habitats and latitudes**

The highest number of species was found in the genus **Chrysosporium** with 9, **Gymnascella** with 6, **Malbranchea** with 5 and **Aphanoascus** with 4 (Table 1, 2, 3).

Of the total of species isolated, we considered 8 teleomorphs together with their corresponding anamorphs (holomorphs) by this reason we will analyze results by basing in a pool of 37 taxa (Table 2 and 3). The most important holomorphs were: **Aphanoascus fulvescens** and its anamorph **Chrysosporium** sp., **A. keratinophilus - Chrysosporium keratinophilus, A. verrucosum - Chr. tropicum, Arthroderma quadrifidum - Trichophyton terrestre** complex and **Gymnoascus reesi;** all of them appear as euridominant according to the latitudinal gradient of the habitat (with over 5% of isolates in the 75% or more of the parameters considered) and as constant (with presence in every parameter). **A. fulvescens** appears as the most cosmopolitan because of its dominance in every latitude and habitat (Tables 2-3; Figures 4a and 4b)).

A second group of important species is made up of stenodominant (appearing in over 5% of the isolates in 25 or 50% of the parameters, being also constant in almost every latitude and habitat (Tables 2-3). Considering both groups latitudinally, we can see that 28,6% tends to bring out in the tropical latitudes (18 to 26º S), such as **A. verrucosus - C. tropicum, Gymnascella dankaliensis, Uncinocarpus reesii - Malbranchea** anamorphs and **Gymnascella aurantiaca.** While in southernmost latitudes (26 to 34º S), a 35,7% is represented by: **A. keratinophilus - C. keratinophilus, Arth.**

FIG. 2 ISOLATED GENERA BY LATITUDE

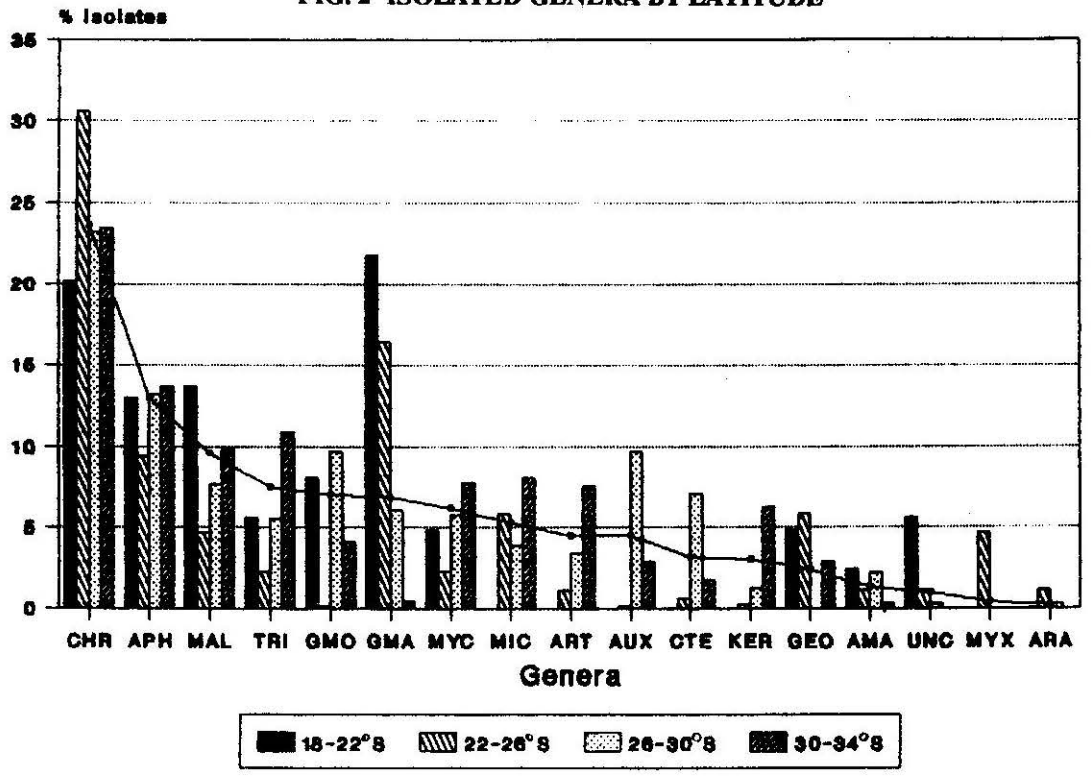


FIG. 3 ISOLATED GENERA BY HABITAT

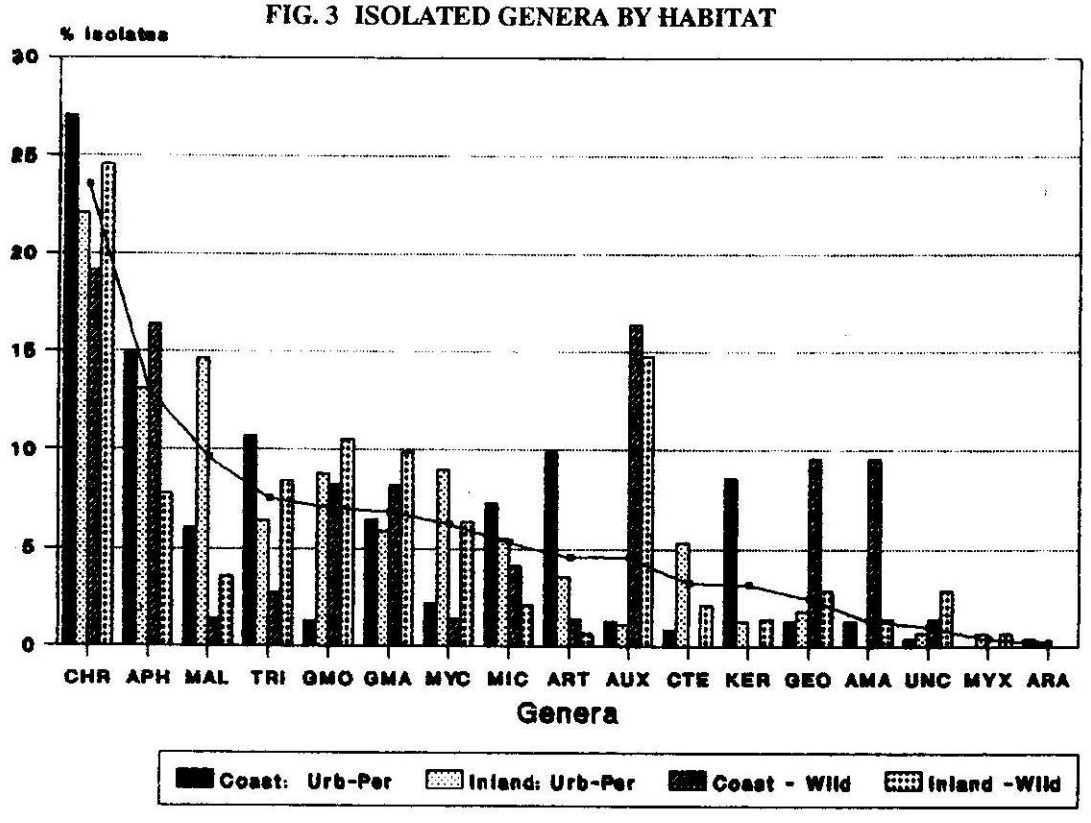


FIG. 4A EURIDOMINANT & CONSTANT TAXA BY LATITUDE

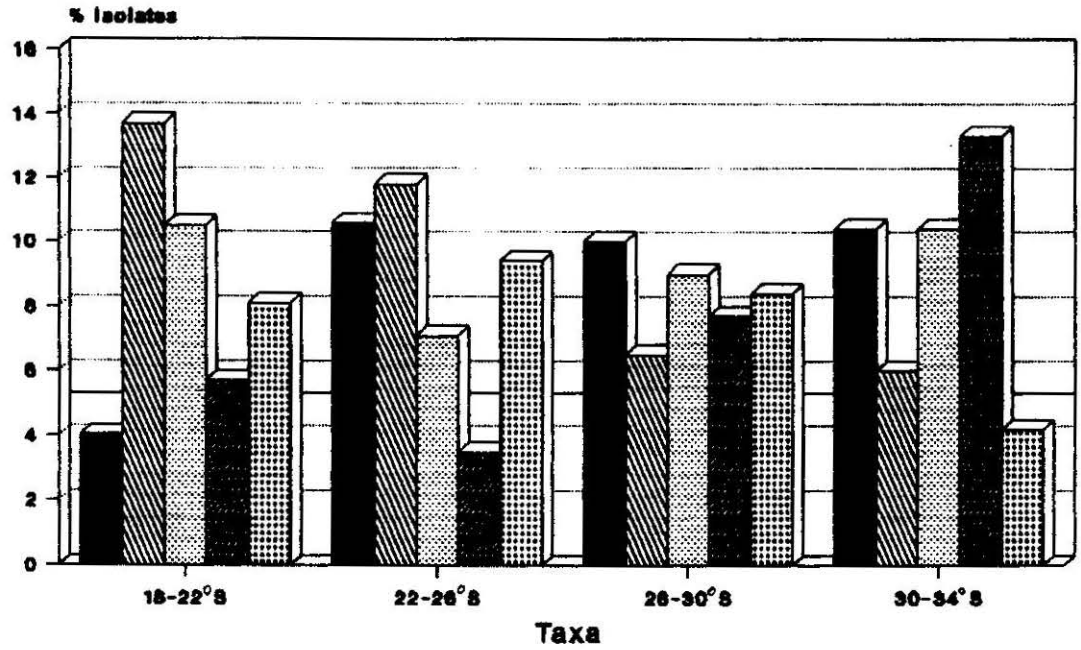
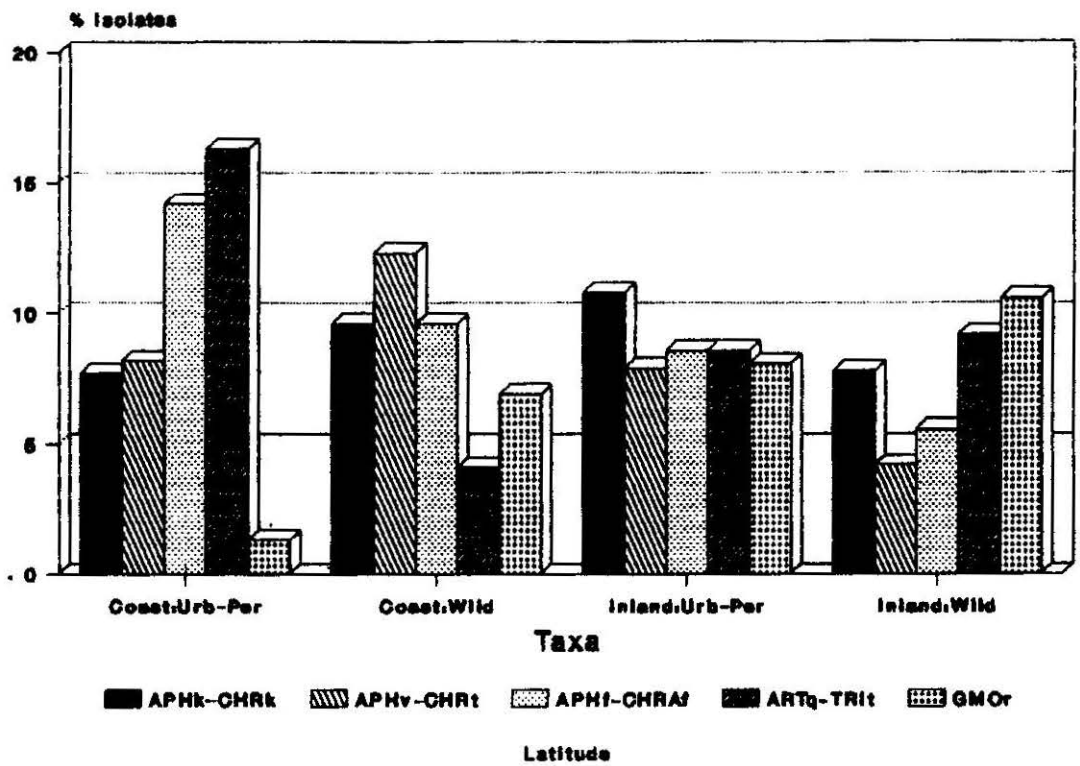


FIG. 4B EURIDOMINANT & CONSTANT TAXA BY HABITAT



quadrifidum - T. terrestre complex, **Ctenomyces serratus - Myceliophthora vellerea, Arth. uncinatum - Keratinomyces ajelloi** and **Chrysosporium pannicola** (Underlined in Table 2).

Taking into account the habitats, 64,3% is more remarkable in a coastal environment rather than inland, showing similar preferences for a wild environment rather than for an Urban-per. one. they are: **A. verrucosum** and its anamorph, **A. fulvescens** and its anamorph, **Arth. quadrifidum** and its anamorph, **Gymnascella dankaliensis, C. pannicola, Geomyces pannorum** var. **pannorum, Auxarthron umbrinum, Arth. uncinatum** and its anamorph and **Amauroascus aureus** (Table 3).

In every latitude, the holomorphs of: **A. fulvescens, A. verrucosus** and **A. keratinophilum** revealed the highest frequency and occurrence, only excelled by **Gymnascella dankaliensis** in 18-22º S latitude and **Trichophyton terrestre** complex in 30-34º S latitude (Table 2).

In the 4 habitats, the 3 holomorphs of **Aphanoascus** appeared again, however **A. verrucosus** is not dominant in the wild inland (Table 3).

The first 21 taxa of the Table 3 (56,8%) were classified as constant because they appeared in 3 or more of the 4 latitudinal zones sampled or in 3 or more of the 4 habitats. Notwith standing **Chrysosporium merdarium, Malbranchea dendritica, Microsporum cookei, Amauroascus echinulatus, Oncocladium flavum** and **Gymnascella aurantiaca** were never dominant (only constant). These taxa could be considered as replacement species (by the dominance) when mycocenosis changes its presence due to abiotic factors as well as to interspecific competence among **Onygenales** and the abundant primary colonizers of the keratine not belonging to this taxon.

In spite of the fact that a good deal of the examined soils are extremely poor in organic matter, especially within 18-30º S latitudes (55, 56, 57, 58), even 30% of them come from extreme (desert) environments for the fungal growth or the development of other microorganisms (See Biogeographical outline), the number of **Onygenales** species and related taxa that was obtained is considerable.

Since the abundance of species was higher in Urban-peripheric zones it is possible to consider these habitats as heterogeneous, disturbed, and with an extensive differentiation of microhabitat (10, 59, 60). Domestic animals directly or indirectly related to the economy of the man, by promoting the dispersion of minor species, because of the continuous expansion and division of their niches (10) make up at the same time a potential reservoir of saprotrophic or potentially biotrophic species which fall upon in the epidemiology of some mycoses (61, 62). The habitat considered as wild bears to the contrary more homogeneity due to the structure of the soils and the little human activity within 18-26º S latitudes, which reverts slowly towards major latitudes. Yet in spite of the climatic rigours of the first latitudes and the increase of the population density in the second ones, it can be considered as undisturbed (4). Its minor fungal community of **Onygenales** can be somewhat related to not only the prevailing abiotic factors but also to a major interspecific competence resulting from the lower amount of microhabitats (63, 64, 65).

b-2) **Reproductive strategies**

In the analysis of the reproductive (teleomorphs) or multiplicative strategies (anamorphs) observed on the petri dishes in the 8 taxa that were submitted as holomorphic (**Aphanoascus fulvescens, A. verrucosus, A. keratinophilum, Arth. uncinatum, Arth. quadrifidum, Arth. gypseum, Ctenomyces serratus, Uncinocarpus reesii**), the multiplicative strategy exceeds (68%) the reproductive one in the latter. When the sampling universe got subdivided into only 2 groups for a wide latitudinal gradient (18 to 26º S and 26-34º S), the first one exhibited a higher rate of multiplication than the second one (with a increase in the reproductive strategy), the coastal and inland habitat (Urban-per.) being, in general terms, the most representative of these 2 strategies (Table 3). **A. fulvescens**, as the only exception, showed mostly its cleistothecia in every latitude (68%), exhibiting its anamorph under a reduced conidiogenesis, sometimes almost absent (a situation not similar in cultures). Conversely, **Uncinocarpus reesii** was most recorded in 18-22º S latitudes and its anamorph in those located southernmost (Table 2).

Changes of reproductive strategies into a multiplicative one along the latitudinal gradient

(42) can be related to: the desert characteristics of the most tropical latitudes, a decrease of niches (little vegetable cover) or to the temperature that can allow genetic adaptations for extended periods of time both in the species and in the conspecific populations by a natural selection (50). Based on the above, **A. fulvescens** especially, **Chrysosporium keratinophilum** and **C. tropicum,** can be considered as eurithermes.

b-3) **Latitudinal distribution patterns and biogeography**

In the quantitative analysis of the **Onygenales** and related hyphomycetes community isolated in all the habitats (Table 3), 12 taxa such as: **A. keratinophilus, A. verrucosus, A. fulvescens, Arth. gypseum, Arth. uncinatum, Arth. quadrifidum, Chr. pannicola, Chr. merdarium, Ct. serratus, G. pannorum,** var. **pannorum, U. reesii** and **Gym. reesii,** exhibit also clear patterns of latitudinal distribution (Table 2); however **Arth. gypseum, Arth. uncinatum, G. pannorum** var. **pannorum** and **Chr. pannicola** become affected to some extent by the latitude. All of these species have a wide distribution in many places of the world (17, 23, 25, 31, 33, 43, 49, 68) and can be classified as "domesticated" because of their close relationship with urban-peripheric habitats and the man's activities. The preference for one or several kinds of habitats can reflect degrees of metabolic adaptation to the diversification of the existing substrata and where the keratine can be one of the main energetic sources and the reservoir for these fungi (31).

Basing ourselves in this major or minor nutritional selectivity, it can be seen that the 12 species considered as domesticated, **G. pannorum** var. **pannorum** and **Gym. reesii** prefer mostly the wild habitat, while **Ct. serratus** and **Arth. gypseum** prefer the urban-peripheric one (Table 3), as to the remaining 8 taxa show signs of preference for these two habitats which are hard to evaluate, or else they get distributed in similar percentages in both of them (Table 3). We can classify the latter as enzymatically self-sufficient and competitively very active taxa (considering their dominance) in environments disturbed by man and animals.

G. pannorum var. **pannorum** and **Gym. reessii** are not considered as keratinolytic (67,68), however the former has been isolated from different types of soil and vegetable detritus as well as from man's skin (67) and animals (41).

As to the second one, it is considered as coprophilous in the excrement of different wild animals (17) and common in desert soils and poor in organic matter (68). Its presence in keratinic baits proves its adaptation to this substratum.

Quantitative and qualitative variations found in the mycocenosis can be analyzed related to the ecosystem yet as the structure of the fungal community has not been sequentially considered in the time, it is not possible to assert the value of the distribution patterns in an age other than the studied one. We will only affirm that the diversity of species in the latitudinal gradient is best appraised in the mesomorphic ecosystem and it can be related to 1) A better climatic stability inducing to a fine specialization and adaptation of communities higher than in areas exhibiting erratic climatic regimes (70). 2) A better stability in organic matter (greater vegetable cover) which promotes an increase in the differentiation of niches (93, 94, 95). 3) And the increase in the population density, the highest in the country within 32-34º S latitudes.

b-4) **Associations among Onygenales.**

The distribution on plates of the most frequently associated **Onygenales** allowed to note two distinct situations between habitat and latitude, where the wild environment in every latitude showed the lowest number and frequency of this associations, without a clear pattern of common species competing for the substratum; while in the urban-peripheric habitat within 18-26º S latitudes, 60% of the plates examined generally 4 taxa got associated to some extent such as: **U. reesii, Ct. serratus, A. fulvescens** and **A. keratinophilus** and its related anamorphs. In the same habitat in 26-34º S latitudes, the highest number of associations was obtained, being **Arth. quadrifidum, Ct. serratus** and **A. keratinophilus** and their anamorphs together with **Chr. pannicola** the most remarkable.

It is difficult to find an explanation for the associations among **Onygenales** in relation to its biotope (31) even more when seasonal variations can affect the course of the succession, distribution and survival of populations.

Our analysis did not take into account the great number of primary colonizers of the keratine that we have isolated (68 taxa) yet not included in this paper. Many of them have a marked keratinolytic activity, especially **Paecilomyces lilacinus**, the most frequently recorded in every habitat and latitude. Situations mentioned above added to the interspecific competence do not allow us to make a further discussion.

c) **Ecological parameters**

Considering Pearson's affinities among latitudes, (Table 4), 2 groups can be easily distinguished: the first one includes 18 to 26º S latitudes where r = 0,74 is very significant ($p < 0,001$) and the second one from 26 to 34º S latitudes, where r = 0,77 is also very significant ($p < 0,001$). This observation is complemented by the fact that similitudes between these 2 groups of latitudes prove to be quite minor and little or not significant at all. This is also confirmed by the clustering among latitudes shown in Figure 5, where it is also observed that the mentioned differentiation takes place inland yet not in the coast.

Table 4

PEARSON'S AFFINITIES AMONG LATITUDES

	22-26ºS	26-30ºS	30-34ºS
18-22ºS	0,74	0,17	0,3
22-26ºS	--	0,49	0,35
26-30ºS		--	0,77

By observing dominances and constancies of species (Table 2), we can see that differences between both groups of latitudes become enlarged by: 1) **Arth. uncinatum** and its anamorph, **Arth. quadrifidum** and its anamorph, **Chr. pannicola** and **Ct. serratus** and its anamorph within 26 to 34º S latitudes and by: 2) **Aph. verrucosus** and its anamorph, **U. reesii** and its anamorph, **Gymnascella aurantiaca, G. dankaliensis, Chry. merdarium** and **G. pannorum** var. **pannorum,** within 18 and 26º S latitudes. The greater abundance of species isolated within 26 to 34º S latitudes which did not appear northernmost also contributes to these differences.

Out of the pool of 37 taxa isolated, only 35% appear in the soils of south latitude (26 to 34º S), among more tropical latitudes (18 to 26º S), to the contrary, only 2 (5,4%) do not appear southernmost (**Arachnomyces sulphureus** and **Myxotrichum deflexum,** Table 2, below).

This greater abundance within 26 and 34º S latitudes does not correspond with the greatest diversities which are observed in intermediate latitudes, especially between 22 and 26º S latitudes, where the observed diversity reaches a 93,8% the maximum one (Table 5).

The smaller diversities in the extreme latitudes are mainly due to the strong dominance of **Arth. quadrifidum** and its anamorph in the southernmost one and **Gymnascella dankaliensis, A. verrucosum** and **U. reesii** in the most tropical latitudes.

The reason for this minor diversity of fungal species is not clear, it can be related to the inability of these soil fungi to adapt themselves to high and low temperatures (46).

This would make it possible to assume that the more stable mycocenosis in the sampling period was the one observed within 22 and 26º S latitudes.

Table 5

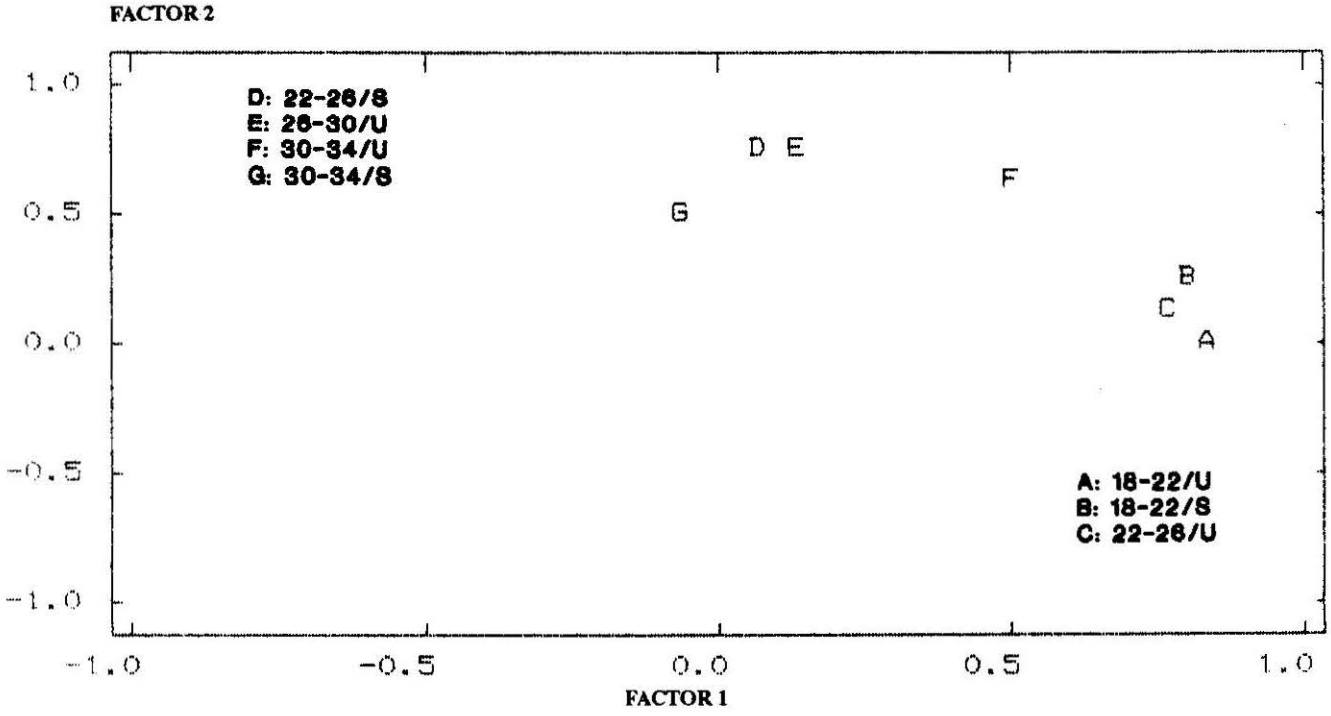
SHANNON-WEAVER DIVERSITY ACCORDING TO LATITUDE (H. and. H. maximum)

	18-22ºS	**22-26ºS**	**26-30ºS**	**30-34ºS**
H	3,72	3,91	4,27	3,88
H max.	4,32	4,17	4,86	4,64
H/H max.	86,1%	93,8%	87,9%	83,6%
Nº species	20	18	29	25

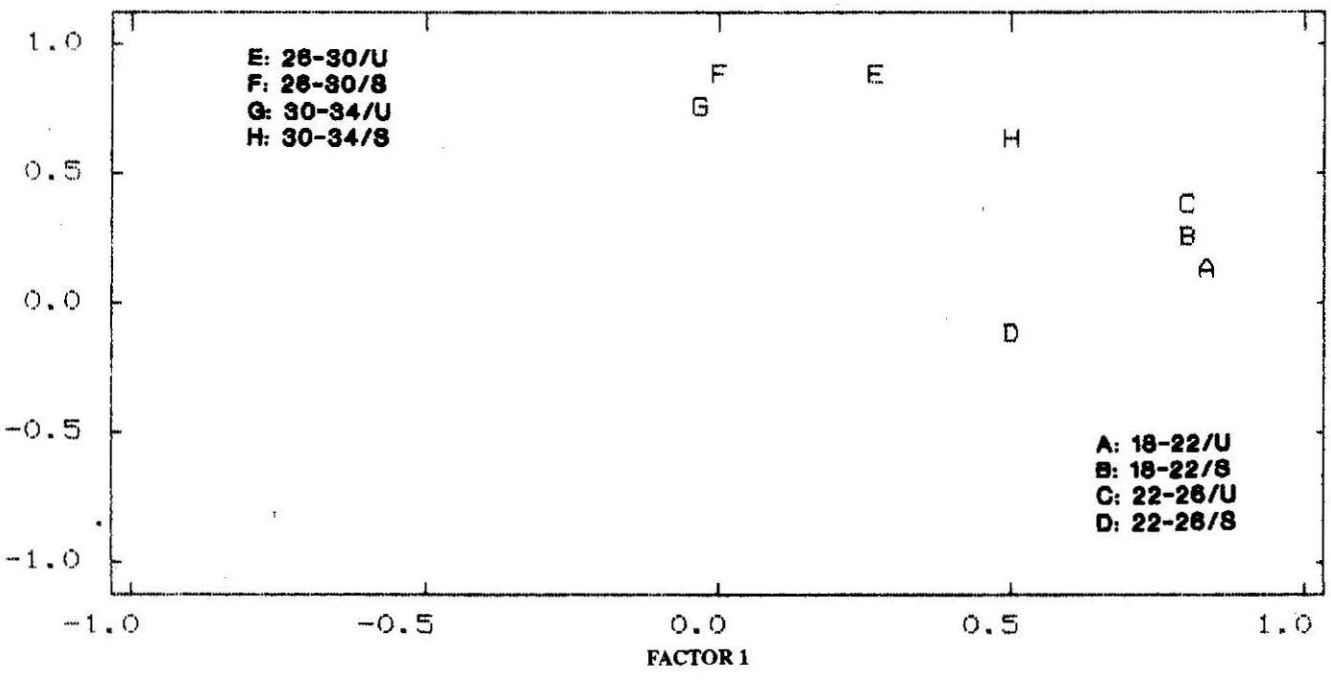
Considering affinities between habitats we can observe that the similitude is significant ($p < 0,001$) among Urban-per. ones and similar to that which is observed among wild habitats (Table 6).

FIG. 5 PRINCIPAL COMPONENT FOR HABITAT & LATITUDE

FACTOR LOADING PLOTS (COAST HABITAT)



FACTOR LOADING PLOTS (INLAND HABITAT)



Conversely, the affinity between Urban-per. and wild is low in the coast yet surprisingly the highest, is found inland. This is also strenghtened by the clustering among habitats shown in Fig. 6 (Table 6).

These observations would denote that: 1) In longitudinal direction (habitat), differences between similitudes would be fewer than in latitudinal direction and 2) Among widely anthrophized (Urban-per.) and wild soils there would be a high inland similitude yet a low one in the coast.

Table 6
PEARSON'S AFFINITIES AMONG HABITATS

Coast:
0,36 (Urban-per vs.Wild) Urban-Per. vs Urban-Per.: 0,57

Inl.:
0,70 (Urban-per vs. Wild) Wild vs. Wild: 0,52

In dominances according to habitat (Table 3), we can see that 9 taxa produce the greatest differences between Urban-per and wild habitats in the coast either because they are absent in some of the 2 habitats or else because they dominate only in one of them.

On the contrary only 5 inland taxa produce this type of differences.

The presence of rare species (distribution of rarity) can be observed in the bottom of Table 3, where the Urban-per. inland habitat is the most represented followed by the Urban-per. of the coast.

The 2 Urban-per. habitats exhibited the lowest diversities in relation to their maximum diversities (Table 7) in correspondence with the remarkable dominances of the holomorphs: **A. fulvescens, Arth. quadrifidum** and **Ct. serratus,** the 2 first ones in the coast and the latter inland

This makes it possible to think that the mycocenosis of wild habitats in the period studied are the most stable ones.

In simultaneous diversities in each habitat and latitudinal zones, wild habitats always show the highest relative diversities (90% or over) without relevant differences in the latitudinal gradient. However inland, relative diversities tend to become equal between Urban-per. and Wild habitats (Table 8)

Table 7

SHANNON-WEAVER DIVERSITIES ACCORDING TO HABITAT
(H and H maximum)

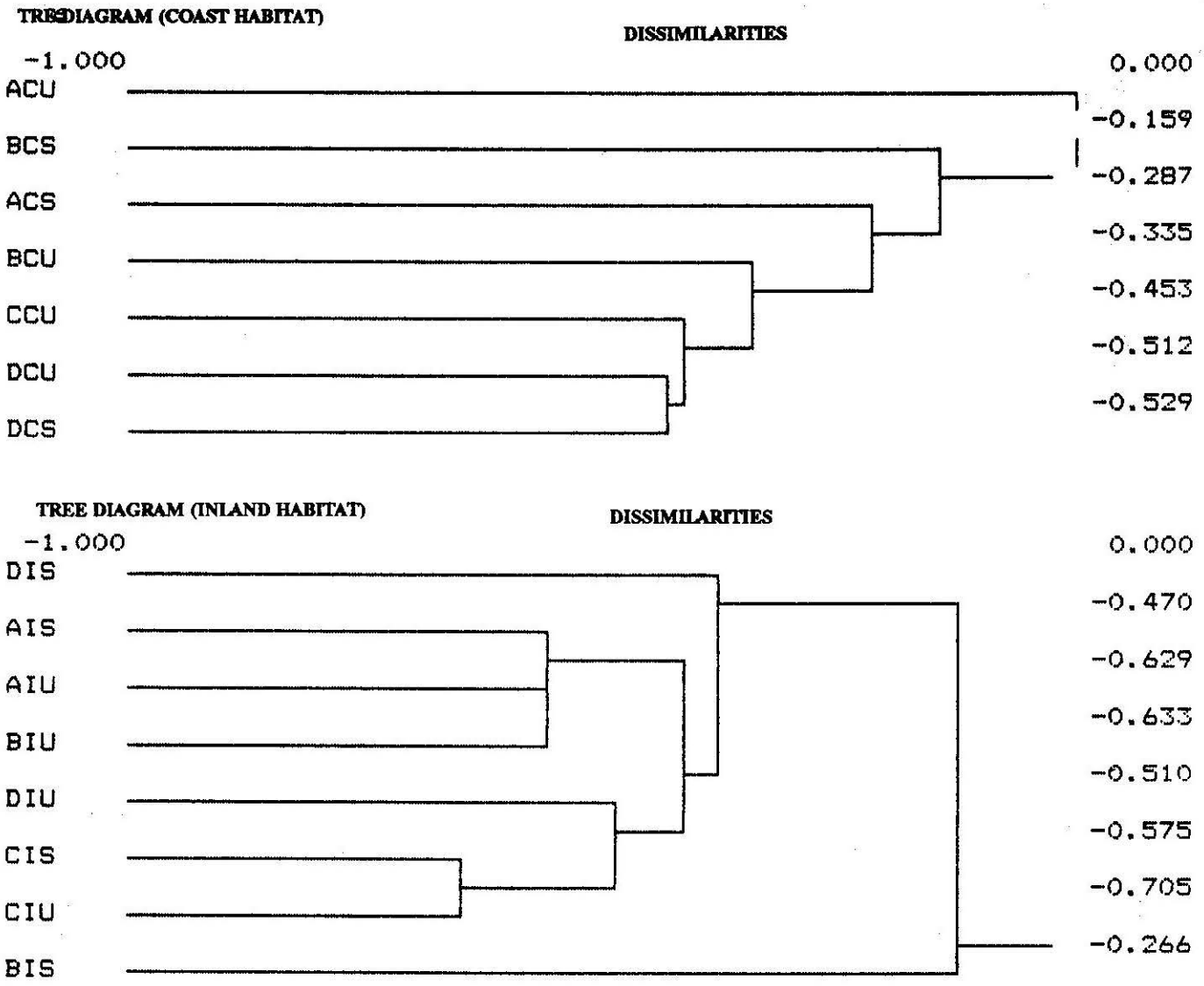
	Coast: Urban-per	Coast: Wild	Inland: Urban-per	Inland: Wild
H	3,81	3,91	4,12	4,20
Hmax.	4,70	4,32	4,91	4,64
H/H max.	81,1%	90,5%	83,9%	90,5%
Nº species	26	20	30	25

Table 8

SHANNON-WEAVER DIVERSITIES ACCORDING TO LATITUDE AND HABITAT
(H and H/H maximum)

	Coast: Urban-per	Coast: Wild	Inland: Urban-per	Inland: Wild
18-22ºS	3,42 (89,8%)	2,66 (94,7%)	3,36 (90,8%)	2,99 (89,8%)
22-26ºS	3,47 (88,7%)	-	3,61 (94,7%)	3,08 (92,8%)
26-30ºS	3,46 (90,8%)	3,54 (92,9%)	4,09 (87,02%)	3,49 (91,6%)
30-34ºS	2,88 (75,6%)	3,14 (94,6%)	3,65 (87,5%)	3,31 (89,4%)
	H (H/H max)	H (H/H max)	H (H/H max)	H (H/H max)

FIG. 6 CLUSTERS BETWEEN HABITAT & LATITUDE



A	=	Lat. 18-22º S	U	=	Urban Perif
B	=	Lat. 22-26º S	S	=	Wild
C	=	Lat. 26-30º S	C	=	Coast
D	=	Lat. 30-34º S	I	=	Inland

(vg. AIU = Lat. 18-22, Inland, Urban Perif)

d) The general taxonomic problem in the "Onygenales"

It is not possible to discuss the results of this investigation without a partial consideration of the wide literature available in the taxonomic suprageneric and generic ranges of the Ascomycota classified either as **Eurotiales, Onygenales** or **Gymnoascales**. The acceptance or not of the nomenclature in force is not the goal of our research work and the sympathy for some scheme reflects rather a practical and objective situation. References included represent only a part in the present state of this fungal systematics. The identification of them is extremely difficult because names have been used inconsistently, and one reason for confusion among them is that the species have been wrongly named or no longer considered valid by one or other specialist.

In the biology of Onygenales, the enthusiasm of the taxonomists seems to have not stopped, creating nomenclature problems amog the mycologists (Ex. 12, 13, 14, 15, 16, 17, 19,). This position produces an alteration in the necessary taxonomic stability which only has to be accepted when changes arise from a more thorough understanding of evolutionary relationship (71, 73).

d-1 **Onygenales- Eurotiales Relationships**

The Ascomycetes considered as **Onygenales** have their origins since the typification of **Onygena** (**Onygenaceae**) done by Fries 1884. Ranges of Family and Order have been widely and disagreeingly used without satisfying most of the taxonomists. The new concepts of order and its 4 families proposed by Currah (17) seems to have the highest consensus at present, although previously Malloch (21, 22, 72) arranged its members into different Orders scattered within the ascomycetes, a situation not accepted by Benny & Kimbrough (18).

Von Arx & van der Walt (76) showed the gross similarity in conidiogenesis of species of **Eurotiaceae** and **Onygenaceae**, stating that terms such as "phialide, separating cell, schizolytic or rhexolytic" are difficult to delimit, superfluous and misleading (95-96).

Von Arx (16) in an interesting reevaluation of the **Eurotiales** gathers in the Order only 4 families, 3 of which are a part of most **Onygenales** sensu Currah (17); **Eurotiaceae** Clement & Shear, **Gymnoascaceae** Baranetzky (incl. **Arthrodermataceae** Currah). **Onygenaceae** Fries (Synonyms: **Monascaceae, Trichocomaceae, Cephalothecaceae, Eremascaceae, Thermoascaceae, Myxotrichaceae**) and **Amauroascaceae** von Arx. (Fennel (74) includes 9 families in the **Eurotiales**, Benny & Kimbrough 2 (18), while Alexopoulos and Mims (75) only one). The main taxonomic parameters of this arrangement are: the shape, size and symmetry of the ascospores, the structure of the asci and the morphology of the ascomata initials, considering that phylogenetically there must not be a separation between the **Eurotiales** and **Onygenales** because of its relationship to **Endomycetales** and **Erysiphales**. This is an advanded scheme which we must appraise cautiously especially in the **Onygenaceae** wherein genera are still considered under the terms of "blastic and thallic".

Erikson & Hawsworth (77), in their outline of order and families and genera of the ascomycetes, do not agree with this scheme. In spite of the fact that the arrangement of the generic characteristics seems to be significant in the **Eurotiales**, this situation does not seem to become reflected yet at the suprageneric levels.

d-2) **Aphanoascus Zukal**

The synonymia of **Aphanoascus** Zukal with **Anixiopsis** Hansen, imposed by Apinis (78) still seems to cause disagreement in the literature. While de Vries (79), Gueho et al. (80). Gueho and de Vroey (81), consider **Anixiopsis** as a different genus, Domsch et al. (68), Von Arx (14, 16) and Currah (17, 82) accept Apinis's opinion. These disagreements have arisen old and contemporary conclusions of little taxonomic contribution making dificult the way for the investigators dedicated to the study of these fungi.

With Benny and Kimbrough (18) accepting the inclusion of **Aphanoascus** in the **Trichocomaceae** (**Eurotiales**) by basing themselves only on the neotypification of the type species **Aphanoascus cinnabarinus** Zukal, done by Undagawa and Takada (83), its already difficult suprageneric position in the **Onygenaceae** gets complicated due to its anamorph in **Paecilomyces**. **Aphanoascus** has already been included in the **Cephalothecaceae** (**Eurotiales**) by Apinis (78), in the **Onygenaceae** (**Onygenales**) by Malloch and Cain (21) Currah (17, 82), and finally in the **Amauroascaceae** (**Eurotiales**), by von Arx (16).

Cano (49) Cano and Guarro (69) by ordering and redescribing the genus, accept the validity of **Aphanoascus,** including within the latter **Anixiopsis** Hansen, **Keratinophyton** Randawa & Sandhu, **Xynophila** Malloch & Cain and **Neoxenophila** Apinis and Clark as synonyms. Thus, and based mainly on the cultural and morphological characteristics, they enlarge the delimitation of the taxon as the number of the involved species which increase from 5 to 14 (with the recent species **A. australis**, and **A. punsolae** (84). As descriptions of the ascospores were carried out under a Scanning electron microscope (SEM), the observation of some features of the epispore under the optical microscope are not easy to view, as well as the close margins of their measurements among some especies (width and length) especially when small morphological differences observed in some of its anamorphs in **Chrysosporium** and **Malbranchea** are evident.

Cano (49) includes **Chrysosporium tropicum** as anamorph of **Aphanoascus verrucosus** Cano and Punsola. Later on, Cano and Guarro (69) mention **Chrysosporium** sp. as the anamorph of this species, arguing that its conidia are similar to **C. tropicum.** With this, the position of **C. tropicum** seems doubtful and looks like what happened with some strains equal to **C. keratinophilum,** that are members of an anamorph pool being morphological very similar (complex?). **Aphanoascus, Chrysosporium** and **Malbranchea,** seem to have a considerable amount of genetic variations, this could differ in the way that this is distributed among the existing population, making the taxonomic arrangement at species level difficult.

Consequently, if the teleomorph-anamorph relationship (with some exceptions) lacks a taxonomic usefulness, which turns out to be undesirable, thus **Chrysosporium** looks morphologically more complex and heterogenous, a point of view which is agreed by many advanced mycologists. It is necessary a better delimitation with genetic studies which may bring many surprises that we are not able to appraise yet in the whole.

After the revision of **Aphanoascus** by Cano & Guarro (69) we have restudied the majority of the isolated strains, their descriptions and slides of **A. fulvescens** and **C. keratinophilum** kept during this work. Many of these strains were reclassified as **A. fulvescens** and **A. keratinophilus**. We have the impression that our percentages of **A. fulvescens** may be slightly higher than the ones here included, confirming its euridominant category.

d-3) **Gymnascella** Peck. and **Gymnoascus** Baranetzky

The genus **Gymnascella** Peck., was described for the single species **Gymnascella aurantiaca** Peck 1885, placed in the N.Y. State Museum with an inadequate description for recognizing the fungus. Saccardo (85) reclassifies it into **Gymnoascus**, what was confirmed later on by von Arx (13), who considers it as **Gymnoascus reessii**. Orr et al. (19) reintroduced the genus **Gymnascella** with the type species **Arachniotus verruculosus** Orr and Kuehn (= **A. aurantiacus**) because of its priority over the genus **Arachniotus** Schroeter. Currah (17) reexamines an isotype of **Gymnascella aurantiaca** located at TRTC and finds that it represents the same taxon as **Arachniotus aurantiacus** Kamysc, therefore he confirms the priority of **Gymnascella** over **Arachniotus.** He places all oblate ascospore species in the first and those with double equatorial band in the second.

Gymnascella is a polyphiletic and heterogeneous genus which comprises at present most of the species previously included in **Arachniotus** (excluding **A. ruber**) as well as **Pseudoarachniotus** Kuehn, **Plunkettomyces** Orr, **Petalosporus** Ghosh et al, **Narasimhella** Thirum & Mathur and **Waldemaria** Batista.

The inclusion of **Narasimhella** is not agreed by von Arx & Samson (86) because this taxon is not closely related due to its bivalvate ascospore, even though these authors accept that the 12 species described by Currah (17) in **Gymnascella** are valid and well delimited. The constant efforts to avoid proliferation of genera in the **Gymnoascaceae** and **Onygenaceae** made by von Arx (12 - 13 - 14) continue with the enlargement of the generic concept of **Gymnoascus** done by this investigator (15) who encompasses within the latter every **Gymnoascaceae** with lenticular or discoidal (not bivalvate), circinate, arqued or comb-like appendix ascospores. Therefore he considers **Gymnascella** and all the genera before mentioned to be synonyms of **Gymnoascus**.

If the possible simplification of the ascospores forms from the complex ones like the **Gymnoascus ruber** (= **Arachniotus ruber**), with equatorial groove bordered by distinct ridges and pole thickened, to **Gymnoascus desertorum** (= **Gymnascella confluens** = **Arachniotus desertorum**) with a broad shallow equatorial depression, to **Gymnoascus reessii,** with smooth and oblate ascospore, can represent an evolutionary route, it is not less valid

that many mycologists may think that the identity crisis has not finished in the **Gymnoascaceae** and **Onygenaceae**. Nevertheless the idea must not be discarded as an alternative of classification also applied without much success in the past by Apinis (11), where he includes within **Gymnoascus** the genera **Pseudogymnoascus** and **Auxarthron**.

The same as Currah (17) we have included in **Gymnascella dankaliensis** (= **Arachniotus dankaliensis**) **Arach. flavoluteus** (= **Pseudoarchniotus flavoluteus**). Nevertheless in some isolates we can appreciate certain morphological differences in the latter.

The taxonomic determination of **Gymnascella littoralis** (?) (= **Plunkettomyces littoralis**) in keratinic substrata, was based on the ascoma, peridial hyphae, and ascospore. The latter are smaller than those described in literature (Phot. 24, 25). The inland (Urban per.) non marine habitat make us doubt if this species is really a smaller variant or belong to another neighborn specie. Nevertheless the ascospore never showed polar thickenning and were always smooth.

In our investigation the delimitation of genus **Gymnoascus** is based in Orr (19) and Currah (17) criteria.

Gymnoascus reessii was the most common species of the genus and the morphological variations of its appendages in the reticuloperidium were better appreciated directly in petri dishes over the keratinic bait (Phot. 1 - 2 - 3).

CONCLUSION

According to the set of ecological and biogeographical conditions analyzed, we can conclude that:

1) The diversity, density and richness of species was:

   a) Higher among 26 to 34ºS latitudes, with a superposition of characteristics from xero and mesomorphic ecosystems which among 18 to 26ºS latitudes show distinct desert-like features.

   b) Higher in most anthropophized (urban-peripheral) and inland habitats, with a greater diversity of niches and organic supply than wild and coastal habitats.

   c) Higher in the species of the genera **Aphanoascus** and **Chrysosporium**, probably due to their greater adaptive and competitive capacity in the latitudinal gradient.

2) The richness of species was observed mainly in relation to the rarest taxa which may seemingly exhibit nutritional, edaphic or climatic limitations in a particular habitat.

3) A similar pattern of latitudinal distribution for 12 cosmopolitan taxa in the seasonal period studied could be seen, what made to consider them as euridominant or as stenodominant because of the efficient production, dispersion and survival of their propagules in the different habitats. Species with a high population density in the different geohabitats of the latitudinal gradient kept a close equilibrium among themselves and the remaining mycota of the community. The composition of the various macro and microhabitats can be conclusive in the structure of the community present in them, giving rise to a model of population organization able to exploit the diversity of existing substrata with similar efficiency.

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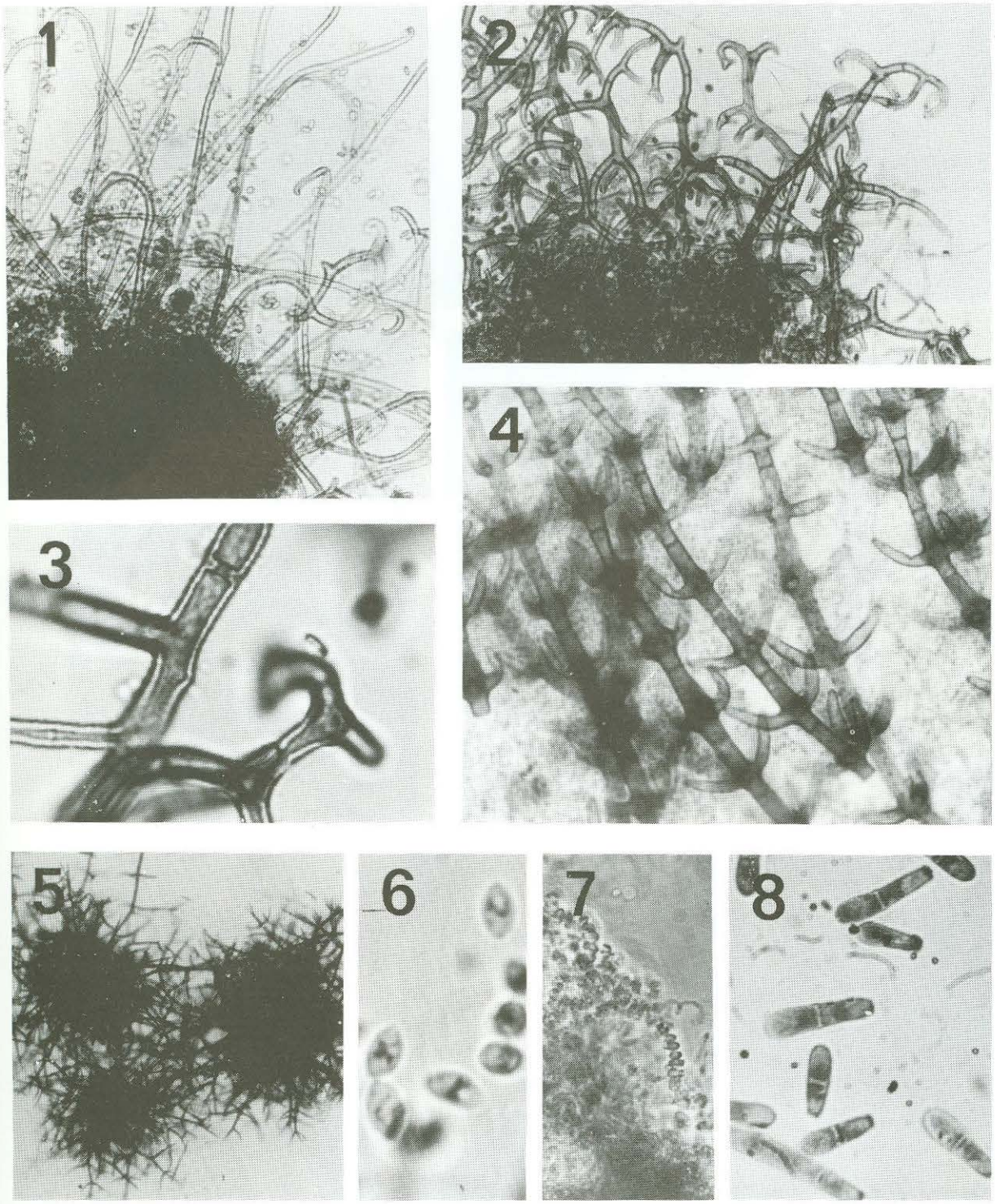
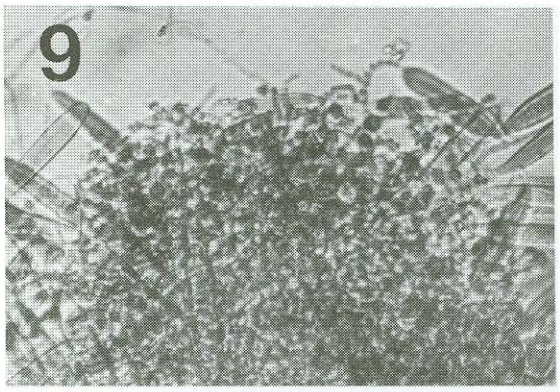
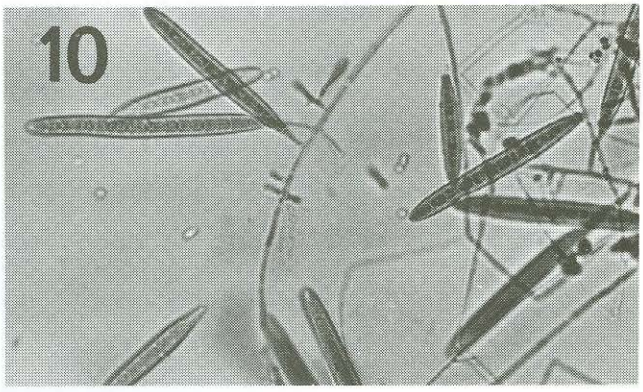
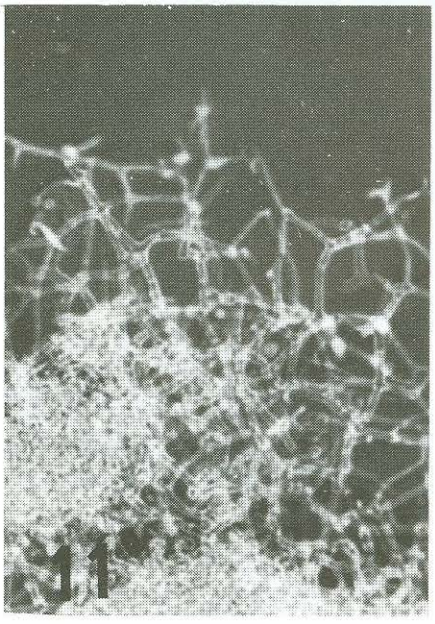
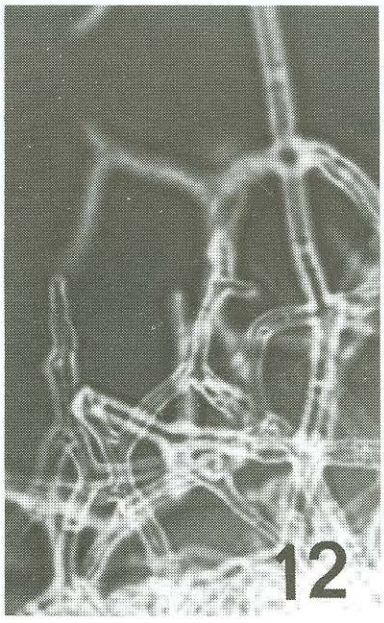


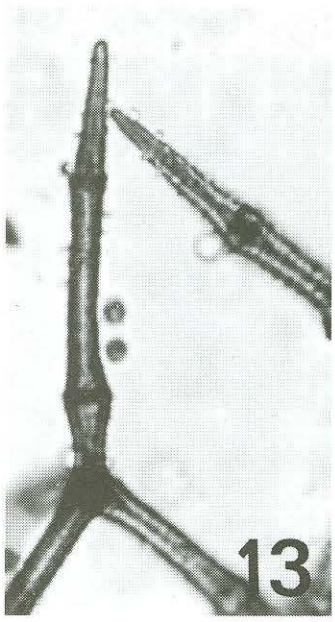
1, 2, 3 **Gymnoascus reessii** (= **G. longitrichus**) Range of variability in long axis of peridial appendages. 200X. Characteristics peridial appendages. 400X. "Boat Hooks" appendages in the reticuloperidium 1000X. 4. **Oncocladium flavum** and his synnanamorph **Malbranchea flava.** Reflexed appendages in verticils. 200X. 5, 6. **Myxotrichum deflexum** Ascomata and peridial appendages monopodially branched. 100X. Ovoid to clavate ascospores. 1000X. 7,8. **Arthroderma quadrifidum.** Peridial hyphae. 400X. **Trichophyton terrestre** complex, anamorph of **A. quadrifidum:** Micro and macronconidis. 1000X. 9. **Arthroderma uncinatum**. Ascoma, peridial hyphae and his anamorph. 400X 10. **Keratinomyces ajelloi** anamorph of **A. uncinatum.** Macro and microcionidia 400X. 11, 12. **Gymnoascus intermedius** Ascoma and peridial hyphae. 300X. Anastomosing peridial hyphae branched at right angles. 700X.

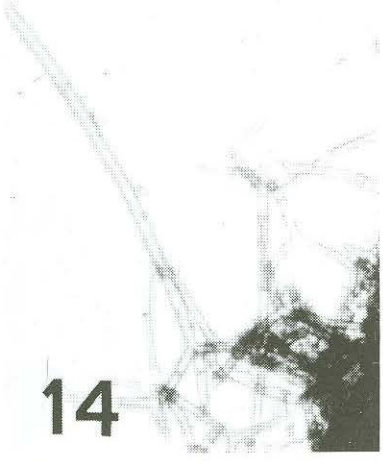


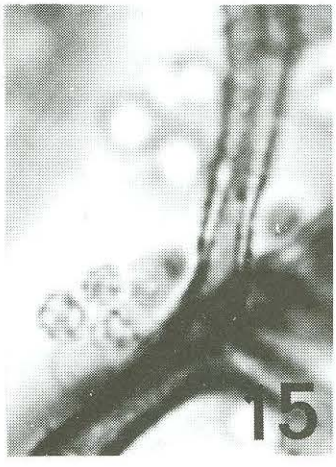


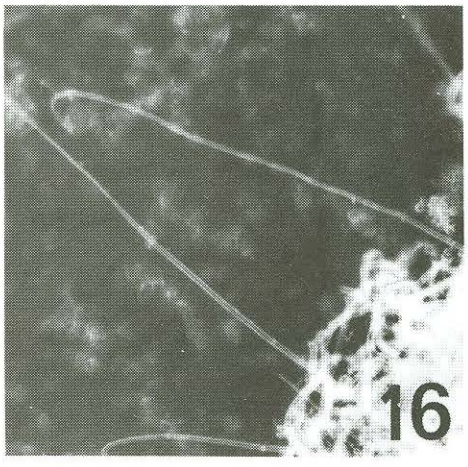




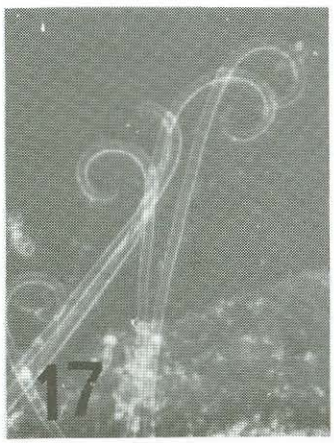


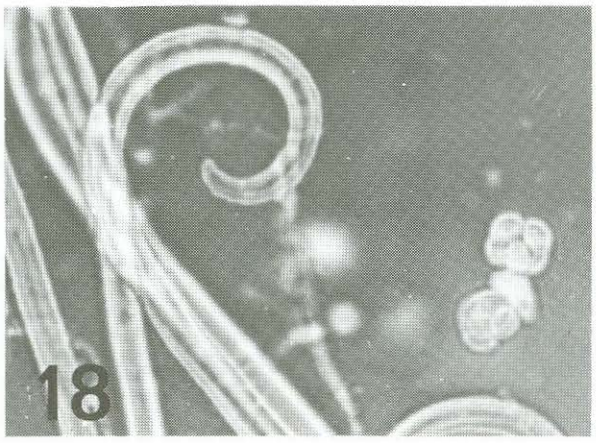


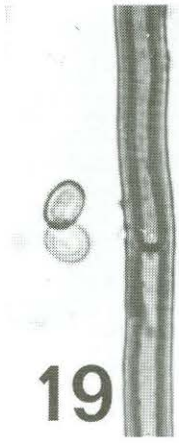


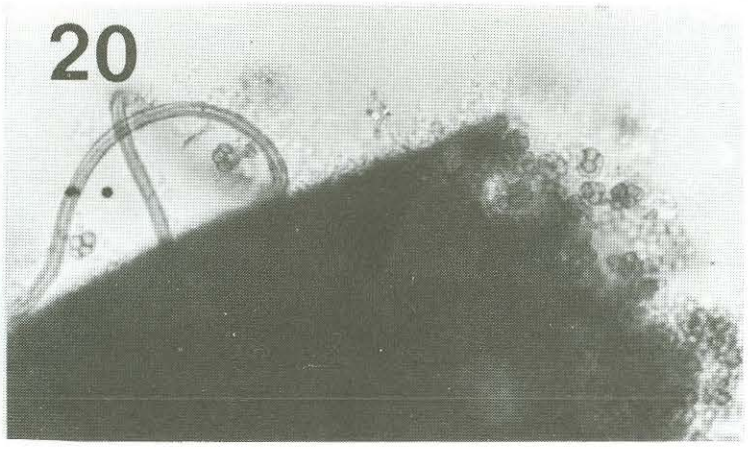


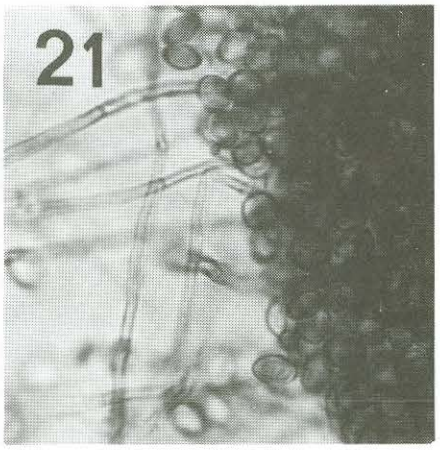
13, 14, 15. **Auxarthron umbrinum** Asperulates, "spine like" appendages 1000X. Typical long peridial appendages with uncinate apices 250X. Cluster of asci and punctate-reticulate ascospores. 1000X. 16. **Auxarthron californiensis.** Part of the peridial ascoma with uncinate appendages 1000X 17, 18, 19. **Uncinocarpus reesii.** Aseptate, uncinate appendages. 200X., Appendages and cluster of asci and ascospores. 1000X. Portion of appendage (with a septa) and oblate ascospores 100 X. 20. **Arachnomyces sulphureus.** Portion of the pseudoparenchymatous peridium with flexuose and circinate appendages, cluster of asci and ascospores. 600X 21, 22. **Gymnascella aurantiaca.** Peridial byphae of the ascoma and ascospores 700X and 1000X 23. **Gymnascella confluens** Ascospores with a broad, equatorial furow (arrow) 1000X 24, 25. **Gymnascella littoralis.** Ascospores with an equatorial rim in lateral and frontal view. 1200X. Ascospores 1000X.

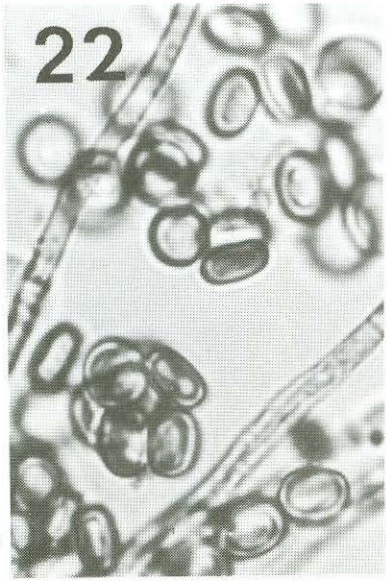


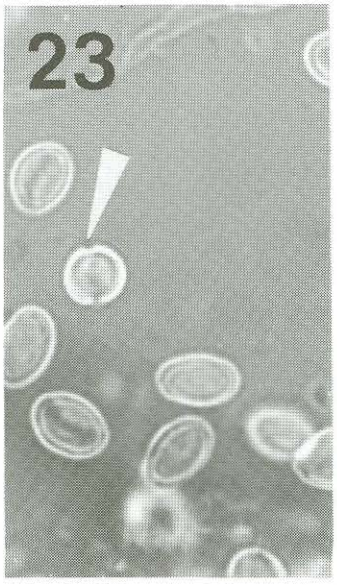


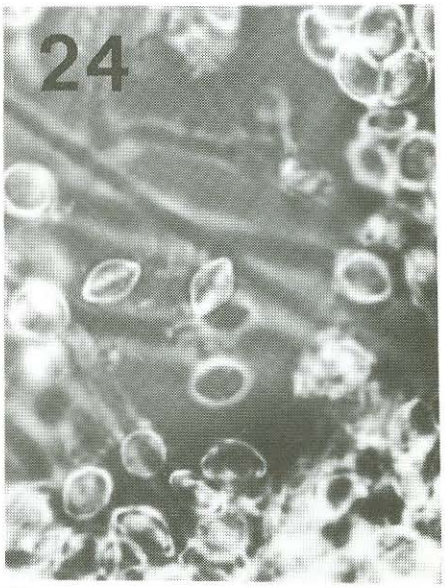




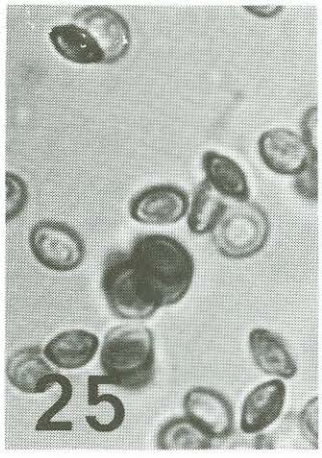








26. **Gymnascella dankaliensis** Ascospores with equatorial and polar thickenings. 1000X 27. **Gymnascella citrina** Ascospores with polar thickenings and equatorial ring. 1000X 28, 29. **Aphanoascus fulvescens.** Pseudoparenchymatous peridium with irregularly punctate and ridged ascospores. 1000X. 30. **Chrysosporium** sp., anamorph of **A. fulvescens,** Conidia 1000X. 31, 32. **Aphanoascus keratinophilum.** Pseudoparenchymatous peridium and ridged ascospores. 1000X. 33. **Chrysosporium keratinophilum,** anamorph of **A. keratinophilum.** Conidia 700X. 34. **Chrysosporium pannicola,** Conidia 1000X. 35. **Spiromastix warcupii.** Peridial hyphae and ascospores 200X. 36. **Chrysosporium merdarium.** Equinulated arthroconidia 1000X 37. **Myceliophthora vellerea** anamorph of **Ctenomyces serrratus.** Conidia 1000X.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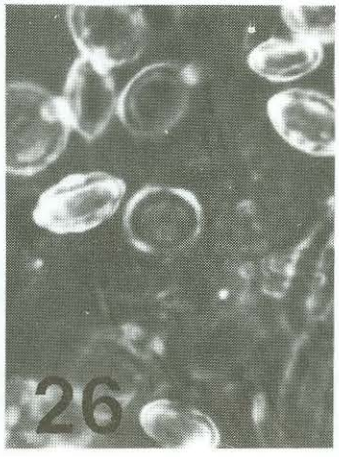
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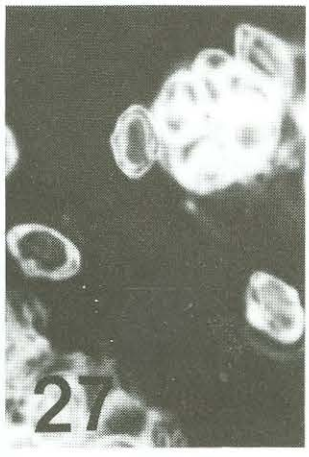
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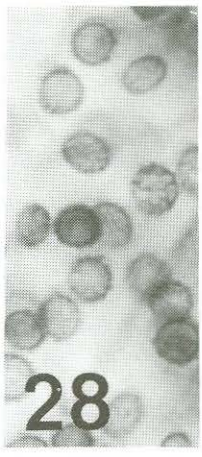
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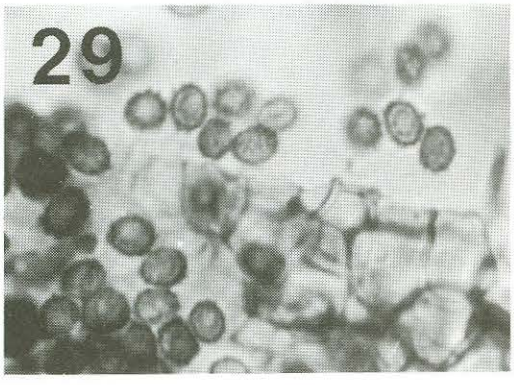
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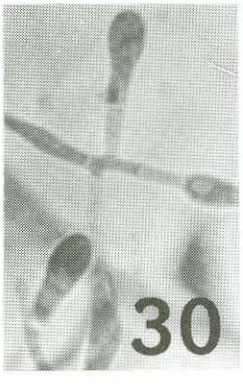
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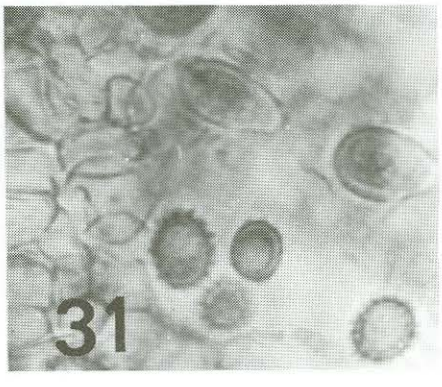
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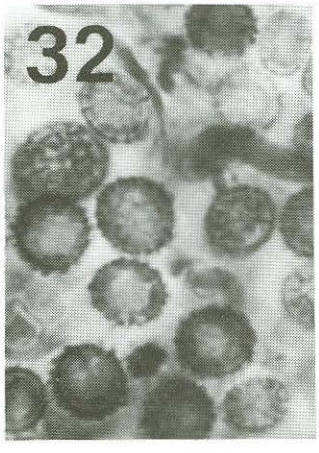
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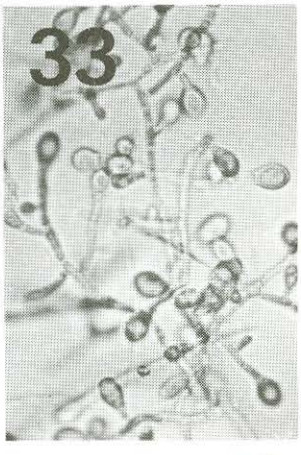
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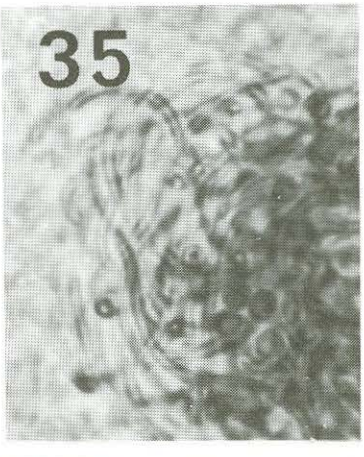
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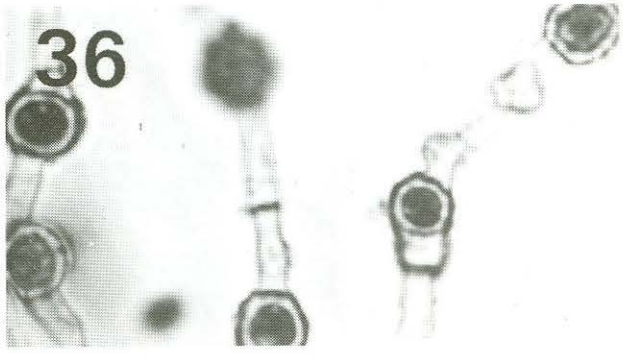
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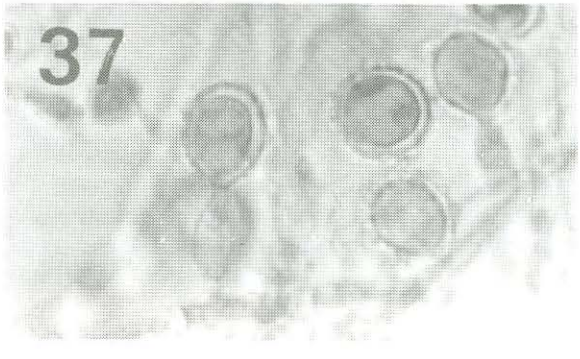
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